

Spotlight on Hydrogen Fluoride

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Several thousand different chemicals are used in chemical laboratories and process operations throughout the DOE complex. One of the most hazardous is hydrogen fluoride. This article spotlights hydrogen fluoride as a hazardous chemical whose manufacture, storage, and use are regulated by both the Occupational Safety and Health Administration (OSHA) and the Environmental Protection Agency (EPA).

Hydrogen fluoride is a colorless, fuming gas or liquid with an irritating odor. It has a boiling point of 20°C. It is corrosive and highly toxic, and may be fatal if inhaled. Exposure causes severe eye and skin burns; inhalation may cause pulmonary edema. Contact with dilute solutions (<20% in water) may not produce immediate pain or visible damage. Pain and arrhythmia can be delayed for as long as 24 hours after the exposure.

Although it is not combustible, if involved in a fire, hydrogen fluoride is extremely irritating. It reacts with a broad range of materials and evolves heat when combined with water. Solutions of hydrogen fluoride can etch glass.

Hydrogen fluoride should be stored in a cool, dry, well-ventilated location separate from silica, incompatible metals, concrete, glass, ceramics, and oxidizing materials. Because of strong etching potential, even dilute solutions of hydrogen fluoride should not be stored in glass containers.

Anhydrous hydrogen fluoride is usually shipped in steel cylinders, pressurized tanks on trucks, rail cars, or barges. Solutions are shipped in polyethylene, fluorocarbon, or wax-lined bottles.

Release of liquid hydrogen fluoride at a temperature above its boiling point results in a flashing vapor with aerosol entrainment and the formation of a residual liquid pool. In addition, because hydrogen fluoride is hygroscopic and, when combined with water, forms a complex compound that has a density greater than air, hydrogen fluoride released under high humidity initially forms a dense gas cloud.

Hazard Profile for Hydrogen Fluoride

Chemical	Description	Hazards	OSHA PSM/ EPA RMP Threshold Quantities (lbs)	Exposure Limits ACGIH/ NIOSH/OSHA (ppm, mg/m ³)	ERPG-1/ ERPG-2/ ERPG-3	Properties	Incompatibilities and Reactivities	NFPA Rating N _H , N _F , N _R
Hydrogen fluoride (HF) Synonyms: anhydrous hydrogen fluoride, anhydrous hydrofluoric acid, hydrofluoric acid gas (CAS 7664-39-3)	Colorless gas or fuming liquid (below 20°C [67°F]) with a strong, irritating odor. Hydrofluoric acid is hydrogen fluoride in aqueous solution. Acid attacks glass and other silicon-containing materials.	Highly toxic by ingestion and inhalation. May be fatal if inhaled. Corrosive. Causes severe eye and skin burns. Strong irritant to mucous membranes. May cause pulmonary edema. Corrosive to metals. Nonflammable. Noncombustible.	OSHA: 1000 lbs (anhydrous) EPA: 1000 lbs (conc ≥ 50%)	ACGIH: Ceiling 3 ppm 2.3 mg/m ³ NIOSH: TWA 3 ppm 2.5 mg/m ³ NIOSH: Ceiling 6 ppm 5 mg/m ³ (15 min)	2 ppm/ 20 ppm/ 50 ppm	Boiling point = 20°C (67°F). Freezing/melting point = -83°C (-117°F). Density of liquid form = 0.998 at 14°C (57°F). Vapor pressure = 760 mm Hg at 20°C (67°F). Very soluble in water.	Incompatible with metals, water/steam. Attacks glass and concrete. Reacts with water to produce heat.	4, 0, 1

References

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Acronyms and Abbreviations

ACGIH -	American Conference of Governmental Industrial Hygienists
AIHA -	American Industrial Hygiene Association
°C -	degrees centigrade (Celsius)
CAS -	Chemical Abstracts Service (registry number)
Ceiling -	The maximum allowable human exposure limit for an airborne substance (NIOSH/OSHA). The ceiling value should/must not be exceeded during any part of the workday.
CFR -	Code of Federal Regulations
conc -	concentration
EPA -	Environmental Protection Agency
ERPG -	Emergency Response Planning Guideline (AIHA), chemical concentration in air designed to assist in the development of emergency response strategies
ERPG-1 -	The maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor.
ERPG-2 -	The maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.
ERPG-3 -	The maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.
°F -	degrees Fahrenheit
lbs -	pounds
mg/m ³ -	milligrams per cubic meter
mm -	millimeter
min -	minute
NFPA -	National Fire Protection Association
N _H -	NFPA 704, hazard rating for health
N _F -	NFPA 704, hazard rating for fire
N _R -	NFPA 704, hazard rating for reactivity
NIOSH -	National Institute of Occupational Safety and Health
OSHA -	Occupational Safety and Health Administration
PEL -	Permissible exposure limit (OSHA), a time-weighted average (TWA) chemical concentration in air that must not be exceeded during any 8-hour work shift of a 40-hour workweek
ppm -	parts per million
PSM -	Process safety management (OSHA), regulation that contains requirements for management of hazards associated with processes using highly hazardous chemicals to prevent or minimize the consequences of chemical accidents, promulgated as 29 CFR 1910.119, "Process Safety Management of Highly Hazardous Chemicals"
REL -	Recommended exposure limit (NIOSH), a time-weighted average (TWA) chemical concentration in air for up to a 10-hour workday during a 40-hour workweek
RMP -	Risk management program, (EPA), regulation to prevent accidental releases of regulated substances and reduce the severity of releases that occur, promulgated as 40 CFR Part 68, "Accidental Release Prevention Requirements: Risk Management Programs Under the Clean Air Act, Section 112(r)(7)"
STEL -	Short-term exposure limit (NIOSH/OSHA), a 15-minute TWA chemical exposure concentration in air that should not be exceeded at any time during a workday
TQ -	Threshold quantity, (OSHA/EPA), the amount of a listed substance necessary to be covered by either PSM (29 CFR 1910.119) or RMP (40 CFR Part 68)
TLV -	Threshold limit value (ACGIH), occupational exposure limit recommended by the ACGIH
TWA -	Time-weighted average, the most frequently used exposure guideline term, representing the average concentration over a workday